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the two sciences work in generous rivalry, each eager to add its contribution to the store of general knowledge, to utilize such information as the sister science brings, to criticize it if need be, but always to accord it a respectful hearing.

(*To be concluded.*)

STUDIES IN THE OPHIOGLOSSACEAE—II

A DESCRIPTIVE KEY TO BOTRYCHIUM IN NORTH AMERICA : GROUP OF *B. lanceolatum*

BY RALPH CURTISS BENEDICT

The present treatment is designed to set forth briefly the essential facts of our knowledge of these plants from a taxonomic standpoint. The status of the various units included is not considered. The question of specific limits is a perplexing one throughout the genus, and one which will probably require cultural work, such as the raising of the various forms from spores, and under varying ecological conditions, to settle it satisfactorily. But additional information gained from field and herbarium study will be of value, and any corrections and additions to the account given will be welcome.

For convenience, the genus may be divided into two groups, typified in general by the species *B. lanceolatum* and *B. ternatum*, respectively, and characterized as follows :

Group of *B. lanceolatum* : Bud hairless (*B. virginianum* excepted); commonstalk one-half or more epigean (*B. pumicola* excepted), usually one-half or more the height of the plant (*B. simplex* excepted); spores maturing from late spring to early summer (May to June). Included in this group are the following: *B. simplex* Hitchcock, *B. pumicola* Coville, *B. boreale* Milde, *B. onondagense* Underwood, *B. Lunaria* (L.) Sw., *B. tenebrosum* A. A. Eaton, *B. neglectum* Wood, *B. lanceolatum* (Gmel.) Ångstr., *B. virginianum* (L.) Sw., *B. dichrosum* Underwood.

Group of *B. ternatum* : Bud hairy; commonstalk hypogean, short, usually less than one-quarter the height of the plant; spores maturing from the middle of summer to early fall (July to October) (three exceptions).

The above grouping is probably a natural one, but the proper rank of the two groups and their relationship to each other are problematical. The plants included in the first division fall naturally into three or four evolutionary series, starting in each case from the simplest species in the genus, very appropriately *B. simplex*. But this species may also represent the origin of the second group, and some writers have preferred to place it in this section because of its short commonstalk, and occasionally subternately divided lamina. However, it is surely more closely related to species in the first group, notably *B. tenebrosum*, through which it is connected with other forms of the same general type. No real connecting species is known between *simplex* and the species of the *ternatum* group. The latter form a unified and natural section and have even been given generic rank, but on insufficient data. H. L. Lyon* noted a considerable difference in the development of the young sporophyte of *B. obliquum* on the one hand, and of *B. simplex*, *B. neglectum*, and *B. virginianum* on the other. This difference is interesting, but it cannot be considered of value, even to separate the groups, unless it is shown to be constant for other and diverse species in both groups.

Two other groupings of the species have been made. Milde recognized two subgenera, *Eubotrychium* and *Osmundopteris*. The latter included only *B. virginianum*, and was based on a very artificial character, the fact that in this species, the bud-sheath is partly open. Prantl divided the genus into groups nearly like those used here, but differed in placing *B. virginianum* with *B. ternatum* and others of that type to form his subgenus *Phyllotrychium*, of which the principal distinctive character is the possession of a hairy bud. But *B. virginianum* seems to find its closest affinities with *B. lanceolatum*, and it is more reasonable to suppose that it represents an extreme development of this type than to relate it to the much more different *B. ternatum* group.

In the key that follows, the difficulties in connection with the two smallest species, *B. simplex* and *B. pumicola*, are met by giving descriptions sufficiently complete to prevent the confusion of mature specimens of other species with these, but it is prob-

* Bot. Gaz. 40 : 455-458.

ably impossible to draw up a synopsis or descriptions which will differentiate the very young and immature forms of *B. simplex* from similar forms of *B. tenebrosum* and *B. matricariaefolium* and perhaps others. The identity of such forms can usually be ascertained from the mature plants associated with them. As regards the most closely related units, these are in each case keyed out in pairs, so that doubtful specimens may be traced at least to one of two.

Commonstalk about one-half hypogean, the lamina straight in vernation, entire to once or twice pinnately or sometimes subternately divided into cuneiform to lunulate, usually separated segments; the sporophyl straight in vernation, long-stalked, often one-half to two-thirds the height of the plant (in meadows and pastures, northern North America, Europe, and Asia). 1. *B. simplex* Hitchcock.

Commonstalk all or nearly all hypogean, lamina with the tip bent down in vernation, once ternately divided, the divisions pinnately divided into cuneiform to lunulate, crowded segments; the sporophyl erect in vernation, short-stalked, scarcely exceeding the lamina (in pumice soil, 9000 ft. elevation, Oregon). 2. *B. pumicola* Coville.

Commonstalk nearly all epigeal.

Lamina oblong to ovate or narrowly deltoid, with only the tip or upper part bent down in vernation; the sporophyl erect or with the tip bent down.

Lamina with the tip bent down in vernation, but not clasping the sporophyl, ovate to deltoid, acutish, sessile, usually only once pinnately divided, the segments rhombic to deltoid, acutish (Alaska, also in Europe).

3. *B. boreale* Milde.

Lamina with the tip bent down in vernation and clasping the sporophyl, oblong, rounded, usually sessile or nearly so, only once pinnately divided with fan-shaped to lunulate segments.

Plants usually slender, lamina narrowly oblong, the segments fan-shaped, distant (central New York, northern Michigan, and Montana).

4. *B. onondagense* Underwood.

Plants usually stout, lamina usually broader, the segments lunulate, often close and imbricate (northern North America and Europe).

5. *B. Lunaria* (L.) Sw.

Lamina with the tip or upper part bent down in vernation and clasping the sporophyl, oblong to ovate or sometimes deltoid, usually stalked, entire to twice pinnately divided with cuneiform, oblong, or ovate segments.

Segments mostly cuneiform; sporophyl erect in vernation (in wet woods, northeastern states and Canada).

6. *B. tenebrosum* A. A. Eaton.

Segments mostly oblong or ovate, the sporophyl with the tip bent down in vernation (usually in dry ground at the edge of woods and thickets, northern North America and Europe).

7. *B. neglectum* Wood.

Lamina broadly deltoid, and, with the sporophyl, entirely bent down in vernalion, sessile or nearly so.

Bud smooth, in a closed sheath, plants 5-32 cm. high, lamina 1-6 cm. long, 0.8-9 cm. broad, 1-2 or rarely 3 times divided, the sporophyl short-stalked, about one-fourth the height of the plant, the panicle usually stout and diffuse.

8. *B. lanceolatum* (Gmel.) Ångstr.

Bud hairy, in an open sheath, plants 8-80 cm. high, the lamina 2.5-35 cm. long, 4-42 cm. broad, 3-5 times divided, the sporophyl long-stalked, one-third to one-half the height of the plant, the panicle slender.

Lamina annual, panicle slender (continental North America, also in Europe and Asia).

9. *B. virginianum* (L.) Sw.

Lamina persistent for two to four years, the panicle stouter (Jamaica).

10. *B. dichrosum* Underwood.

A treatment of this section of the genus *Botrychium* is hardly complete without reference to Mr. Davenport, and his contribution to our knowledge of some species in it and their relationships. His pains-taking work with *B. simplex*, and his discovery and exposition of the bud characters by which many of the species may be certainly identified, will probably always remain, from a taxonomic standpoint, the most valuable additions to our knowledge of this group.

NEW YORK BOTANICAL GARDEN.

COLLECTING LIVERWORTS IN JAVA

BY DOUGLAS HOUGHTON CAMPBELL

Two years ago it was my good fortune to spend over three months collecting in Java, perhaps the most interesting region in the world to the botanical student. Wallace pronounced Java to be the most beautiful of all tropical islands, and one who has visited it is inclined to agree with his verdict. Lying as it does only a few degrees from the equator and possessing an exceedingly heavy rainfall and a volcanic soil of extreme fertility, the vegetation shows a luxuriance and variety that far surpass anything I have ever seen in any other part of the world. This great variety is shared by the lower plants, and the liverworts include many forms of the greatest interest.

Java is extremely mountainous, being largely composed of a range of volcanoes, several of which exceed ten thousand feet in height, and there is great difference in the rainfall at various